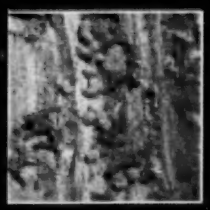

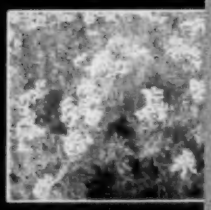

2010 Annual Report

Forest Health in Alberta

Government of Alberta

2010 Annual Report

Forest Health Program
Sustainable Resource Development

Forest Health Vision

To lead Canada in science-based, proactive, adaptive and innovative management of damaging forest health agents in a forest environment with a multitude of values and challenges posed by a changing climate.

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Cover Photo: Hail-damaged young forest regeneration near Robb in southwest Alberta

2010
Annual Report
Forest Health
in Alberta

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Gwen Edge (Graphic Designer, Communications) designed and published the report.

Executive Summary

This is an annual report on forest pest surveys and forest pest management programs carried out under Alberta Sustainable Resource Development's (SRD) Forest Health Program in 2010.

In 2010, the mountain pine beetle, spruce budworms, aspen defoliators, invasive alien plants (weeds) and some abiotic damage agents such as hail and drought were the major forest pests of concern in Alberta.

The mountain pine beetle program is reported on the basis of the 2010 beetle year that spanned from August 15, 2009 through August 14, 2010. Although there was no indication of a major influx of beetles into the province during this period, the long-distance aerial dispersal monitoring indicated further northward and eastward spread of this pest in the province. The results of r-value surveys carried out in 2010 beetle year forecasted a decrease in pine beetle infestations in southern Alberta and along the eastern edge of the infestation where control actions were implemented. However, beetles appeared to be doing well in parts of northwest Alberta. Under the Beetle-focused Strategy, 258,257 infested trees were treated in the 2010 beetle year. Another 2,797 beetle-infested trees were removed under the municipal grant program. Under the Healthy Pine Strategy, about 3.6 million cubic metres of pine wood were harvested either by forest companies or by individual operators from pine stands with high susceptibility to beetles. The heli-GPS aerial surveys carried out in fall 2010 confirmed declining mountain pine beetle infestations in southwest Alberta.

The eastern spruce budworm infestations increased in extent and severity during 2010. The budworm-defoliated area increased by sixty per cent to reach 269,365 hectares in 2010, the highest recorded thus far in Alberta. During this period, the severely defoliated area increased to reach 178,585 hectares; there was a modest fifteen per cent decrease in moderately defoliated area that reached 90,782 hectares in 2010. The moth surveys carried out in 2010 forecasted an increase in the likelihood of new infestations occurring in 2011. Based on this forecast, an aerial spray program to manage this pest in 2011 was proposed for northeast Alberta. However, the egg mass and second instar larval surveys carried out later to verify the need for a spray program forecasted declining budworm populations instead. These survey results prompted scaling down of the proposed 2011 aerial spray program to manage spruce budworm populations in northeast Alberta.

The western spruce budworm defoliated area in southwest Alberta declined dramatically from 30,779 hectares recorded in 2009 to 2,893 hectares recorded in 2010.

Aspen defoliation caused by insect pests continued to decline in 2010. This defoliation was limited to an estimated 62,658 hectares in 2010 compared to 207,243 hectares of defoliation recorded in 2009. Almost all of this defoliation was light in severity. Bruce spanworm was the predominant defoliator of aspen in Alberta in 2010; the forest tent caterpillar and the large aspen tortrix were the other major defoliators of aspen in the province in 2010.

The distribution of major invasive plant species was surveyed to update historical occurrence of these species in the province. Canada thistle, tall buttercup and oxeye daisy were predominant invasive plant species in Alberta in 2010. This year, additional sightings of three invasive plant species, i.e., spotted knapweed, creeping bellflower and bladder campion were reported. SRD carried out several invasive plant management programs on infested Crown lands. In addition, several successful weed management programs were carried out in 2010 in cooperation with

forest companies; oil and gas companies and municipalities. SRD either organized or carried out workshops, courses and demonstrations to increase invasive plant awareness of industry personnel and the general public. To increase public awareness on invasive plant species new set of signs were erected in 2010 at strategic locations in the province.

Extensive hail damage was reported during aerial overview surveys carried out in 2010 in the Upper Athabasca, North Saskatchewan and South Saskatchewan Land-use Framework (LUF) regions. This hail damage was found over a 190-kilometre long swath. This hailstorm damaged many forest trees, irrespective of their species. The young stands were particularly affected. The hail damage occurred over an estimated 45,064 hectares. The Forest Health Section of Alberta Sustainable Resource Development (SRD) will establish plots to monitor long-term impacts of hail damage in the affected areas.

In 2010, the Forest Health Section offered FH100 course in collaboration with the Hinton Training Centre. This course covered all the main aspects of the Forest Health Program. It consisted of a day and half long classroom sessions followed by a day and half of field visits. A training seminar on young stand forest pests was also offered at the Hinton Training Centre by the Forest Health Section. The trainees were educated on major forest pests affecting young forest stands in Alberta. A day-long classroom session on this subject was followed up by a field visit in this two-day long training session.

The 2010 Provincial Forest Pest Management Forum was held at the Northern Forestry Centre in Edmonton under the auspices of the Forest Health Section. This Forum was well attended by an audience that represented the federal, provincial and municipal workers, forest industry and university personnel who shared a common interest in forest health issues of Alberta.

Introduction

This report provides information on the programs carried out by the Forest Health Section of Alberta Sustainable Resource Development (SRD) in 2010, to meet its business goals. Reference is made to other Forest Health-related programs in Alberta if those are either linked to or have a direct bearing on programs carried out by the Forest Health Section. Links are provided, where available, so that the reader can get more detailed information about such programs.

The forest pest-related activities are reported on a calendar year basis, excepting those of the mountain pine beetle (MPB). The 2010 MPB program is reported on the beetle year basis, i.e., August 15, 2009 to August 14, 2010. This period coincides closely with egg laying by MPB females after their flights in 2009 summer through development and flight of resulting generation of MPB adults in 2010 summer.

Forest pest-related data are reported on a Land-use Framework (LUF) region basis. Appendix I shows a map of LUF regions embedded with forest areas, so that the reader can relate between these administrative units.

In 2010, the mountain pine beetle was the focus of the Forest Health Program in Alberta. This year, spruce budworm infestations increased to reach the highest extent recorded in Alberta. The aspen defoliators and invasive alien plants were the other high priority pests dealt with under the 2010 Forest Health Program. Abiotic disorders are becoming increasingly prominent in the province. Among the noteworthy abiotic agents were extensive hail damage, and drought-caused tree distress and tree kill.

The surveys reported in this document were carried out for operational purposes over forested Crown land in Alberta. These surveys do not necessarily cover the entire provincial land base. Although every effort is made to ensure accuracy and completeness of this report, SRD does not guarantee its integrity.

Forest Pest Conditions and Management Programs in 2010

Mountain Pine Beetle Management Program

Objectives, goals and expected outcomes of Alberta's mountain pine beetle (MPB) management program are described in the *Mountain Pine Beetle Management Strategy* (Alberta Sustainable Resource Development, 2007a).

The mountain pine beetle management program began in earnest in 2002 with detection of green attack trees on SRD-managed forested Crown land. Figure 1 depicts occurrence of MPB on forested Crown land in Alberta from 2005 through 2010.

SRD's MPB management program is composed of:

- Detection and assessment of current infestations
- Action to control the MPB

Details of the 2010 MPB program cover the period from August 15, 2009 to August 14, 2010. This time period approximately coincides with the new generation of MPB emerging from eggs laid in 2009 summer through their flight as adult beetles in 2010 summer.

Detection and Assessment of Current Infestations

Long-Distance Dispersal Monitoring

Plots with MPB aggregation pheromone-baited trees were established in July 2009, i.e., before occurrence of 2009 beetle flights, to monitor long-distance aerial dispersal of beetles in Alberta. In each of several strategically pre-selected townships (Figure 2) a plot was set up in a highly MPB-susceptible pine stand. The procedure for dispersal monitoring is described in the "*Mountain Pine Beetle Detection and Management in Alberta*" (Alberta Sustainable Resource

A pheromone-baited pine tree

Development, 2008a). Figure 2 shows occurrence of MPB hits at long-distance dispersal monitoring sites following 2009 flights.

Most pine beetle dispersal activity was recorded along a northeast track in the Upper Athabasca Land-use Framework (LUF) Region. The beetles, most likely originating from current infestations in the Grande Prairie and Peace areas, dispersed over a path extending from east of Jasper National Park through Foothill, Woodlands and Lesser Slave areas in the Upper Athabasca LUF Region to the Lower Peace LUF Region. There were limited MPB flights east of Banff National Park that mainly covered Clearwater Area in western North Saskatchewan LUF Region.

Overview Aerial Surveys

Heli-GPS surveyors, in the fall of 2009, detected and recorded locations of pine trees with red crowns symptomatic of MPB infestations. The procedure for these surveys is described in the SRD *Heli-GPS Manual* (Alberta Sustainable Resource Development, 2007b). These surveys were carried out in all MPB-infested areas except over a section of MPB infestation in northwest Alberta that was earmarked for remote sensing to detect pine trees with red crowns.

The fall 2009 survey results indicated pine trees with red crowns in northern Alberta distributed further north and east than in 2008 (Figure 3). This is in part due to crowns of some MPB-attacked pine in 2009 summer changing colour as early as in 2009 fall. This phenomenon was attributed to tree stress caused by drought conditions prevailing in the affected areas. It was particularly true in the Woodlands and Lesser Slave areas of the Upper Athabasca LUF Region. In southwest Alberta, the number of pine trees with red crowns increased, compared to that in the previous beetle year (Figure 4).

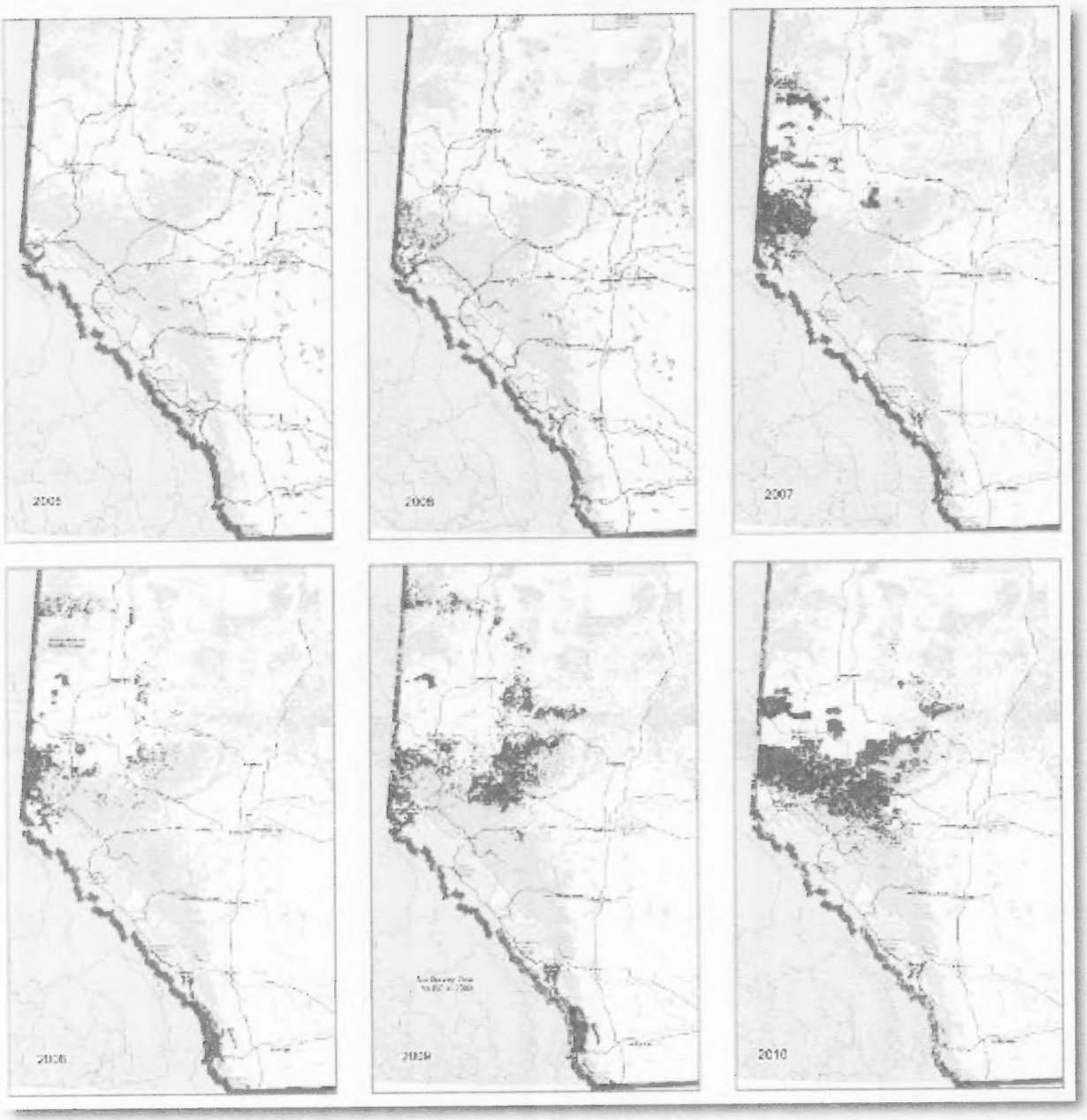


Figure 1.
Aerial survey results showing locations of pine trees with red crowns suspected of being attacked by the mountain pine beetle in Alberta, 2005-2010.

Figure 2.
Results of the MPB long-distance aerial dispersal monitoring pheromone bait program carried out from July to September 2009, Alberta.

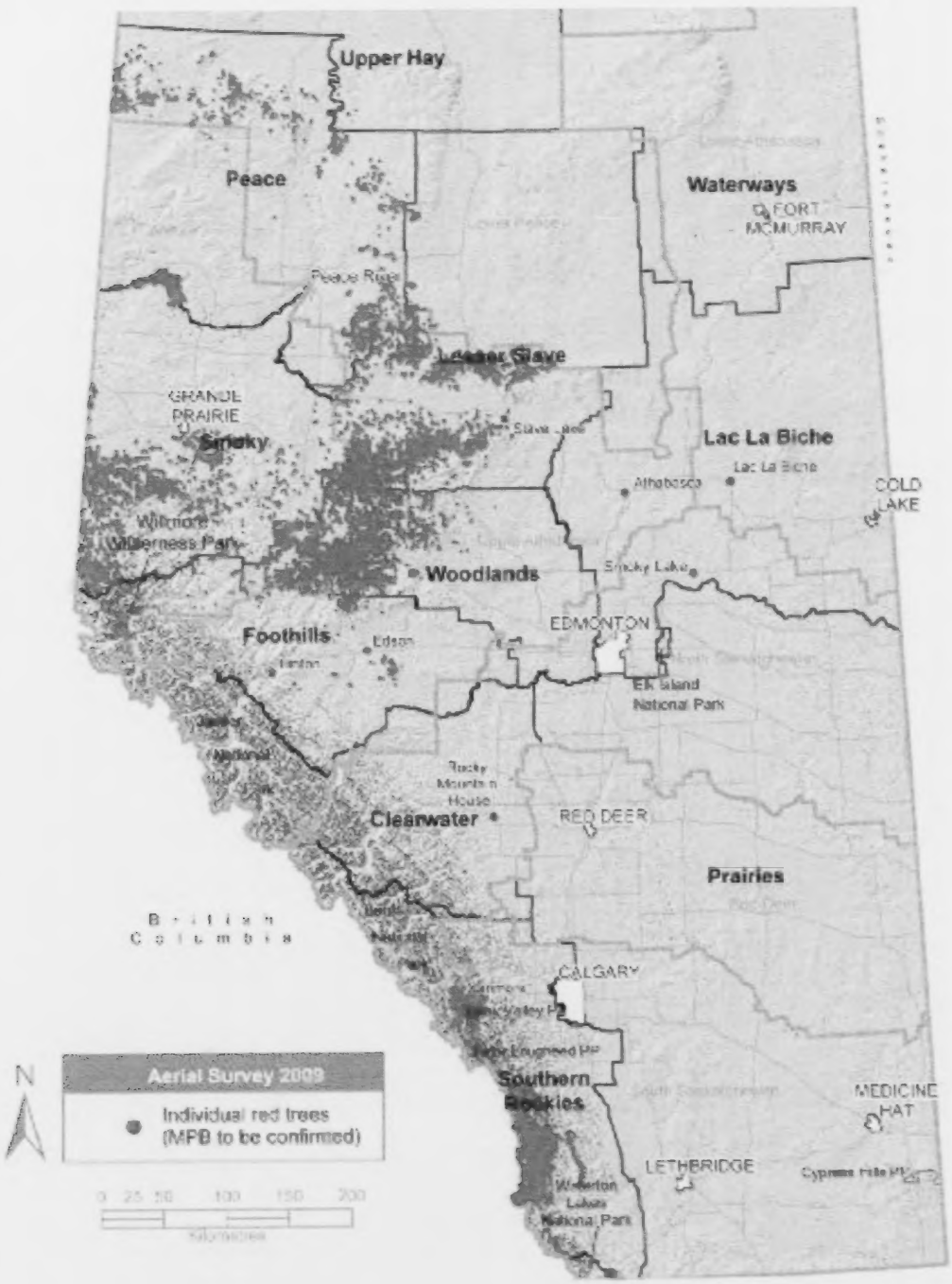


Figure 3.
Heli-GPS survey results showing locations of pine trees with red crowns symptomatic of mountain pine beetle attacks in fall 2009 in Alberta (Note: some MPB-infested areas in the Upper- and Lower Peace regions were not covered in this survey).

Figure 4.
Heli-GPS survey results showing locations of pine trees with red crowns symptomatic of mountain pine beetle attacks in fall 2008 in Alberta.

Ground Surveys to Detect Green Attacks

Ground surveys were carried out in fall through winter of 2009 to detect green attacks in areas earmarked for beetle management in the 2010 beetle year. These surveys were based on locations of pine trees with red crowns that were detected during heli-GPS surveys carried out in 2009 fall. Depending on the distribution of pine trees with red crowns, either concentric or transect surveys were carried out to detect green attack trees. The procedures used for these surveys are described in the manual "*Mountain Pine Beetle Detection and Management in Alberta*" (Alberta Sustainable Resource Development, 2008a).

Green: Red Ratios

The green: red ratios, i.e., ratio of currently attacked trees with green crowns (green attacks) to trees with red crowns attacked year earlier (red attacks), were determined by following the procedures described in the *Mountain Pine Beetle Detection and Management in Alberta* (Alberta Sustainable Resource Development, 2008a).

Figure 5 shows results of the green:red ratio surveys carried out in Alberta in 2009 fall. A green to red ratio of:

- >1 indicates an increasing population;
- <1 indicates a declining population; and
- >7 indicates possibility of beetle immigration to the site.

The green: red ratios indicated increasing MPB populations in northern Alberta (Figure 5).

R-values

R-value is a measure of the rate of increase of MPB populations. R-value at a given site is the standardized average ratio of the number of beetles that entered the bark samples taken from the boles of infested trees to the number of live MPB brood found in those samples. The sampling procedure for r-value determination is described in the "*Mountain Pine Beetle Detection and Management in Alberta* (Alberta Sustainable Resource Development, 2008a)."

In each climatic zone, 15–20 r-value sites were selected based on access, number of infested trees, spatial coverage and climatic suitability for MPB as identified by a model developed by Carroll *et al.* in 2004. R-values were determined in mid-late spring in 2010 after most control operations were completed.

The results of r-value surveys are shown in Figure 6.

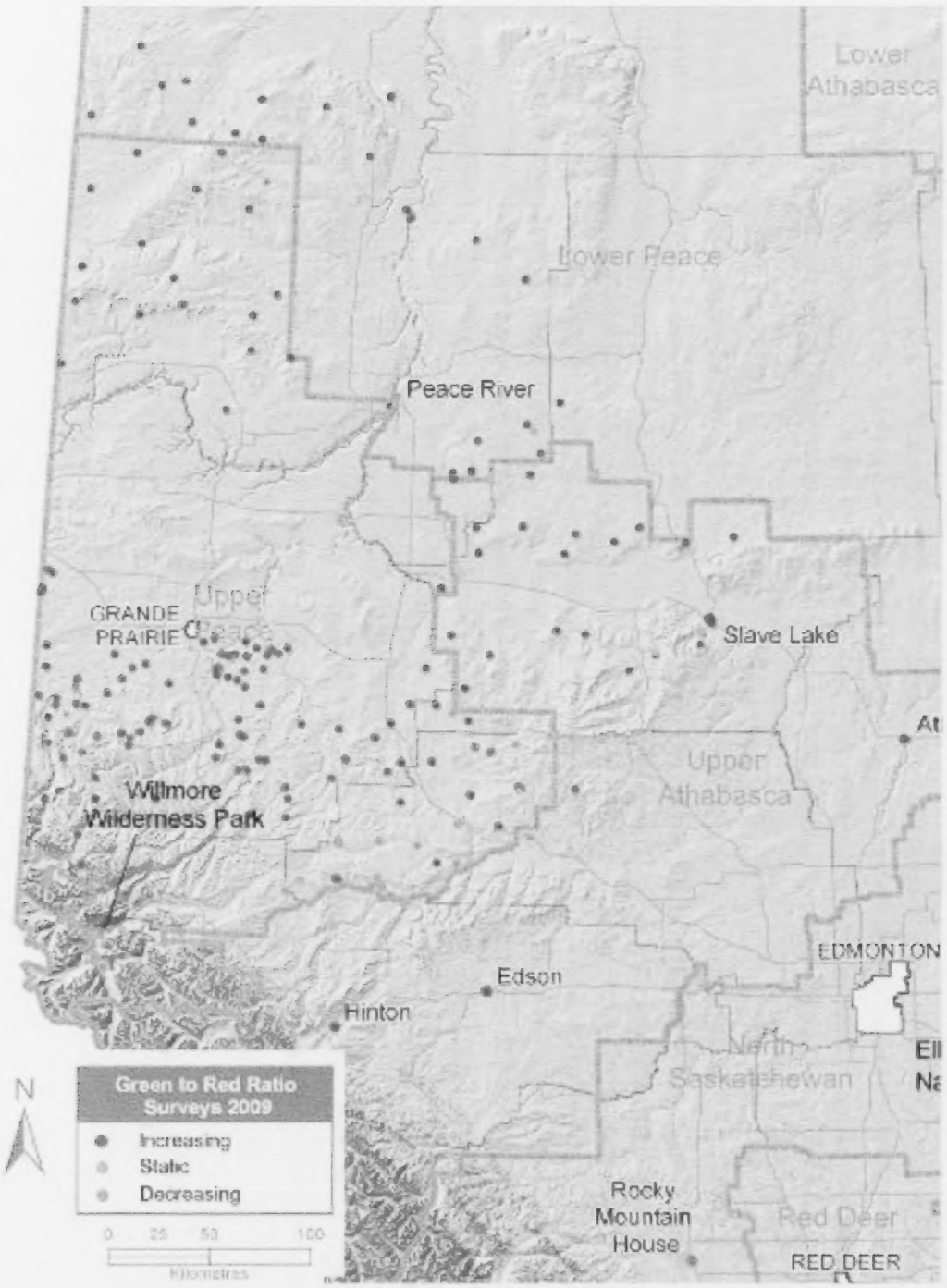


Figure 5.
Results of fall 2009 green: red ratio surveys carried out in Alberta.

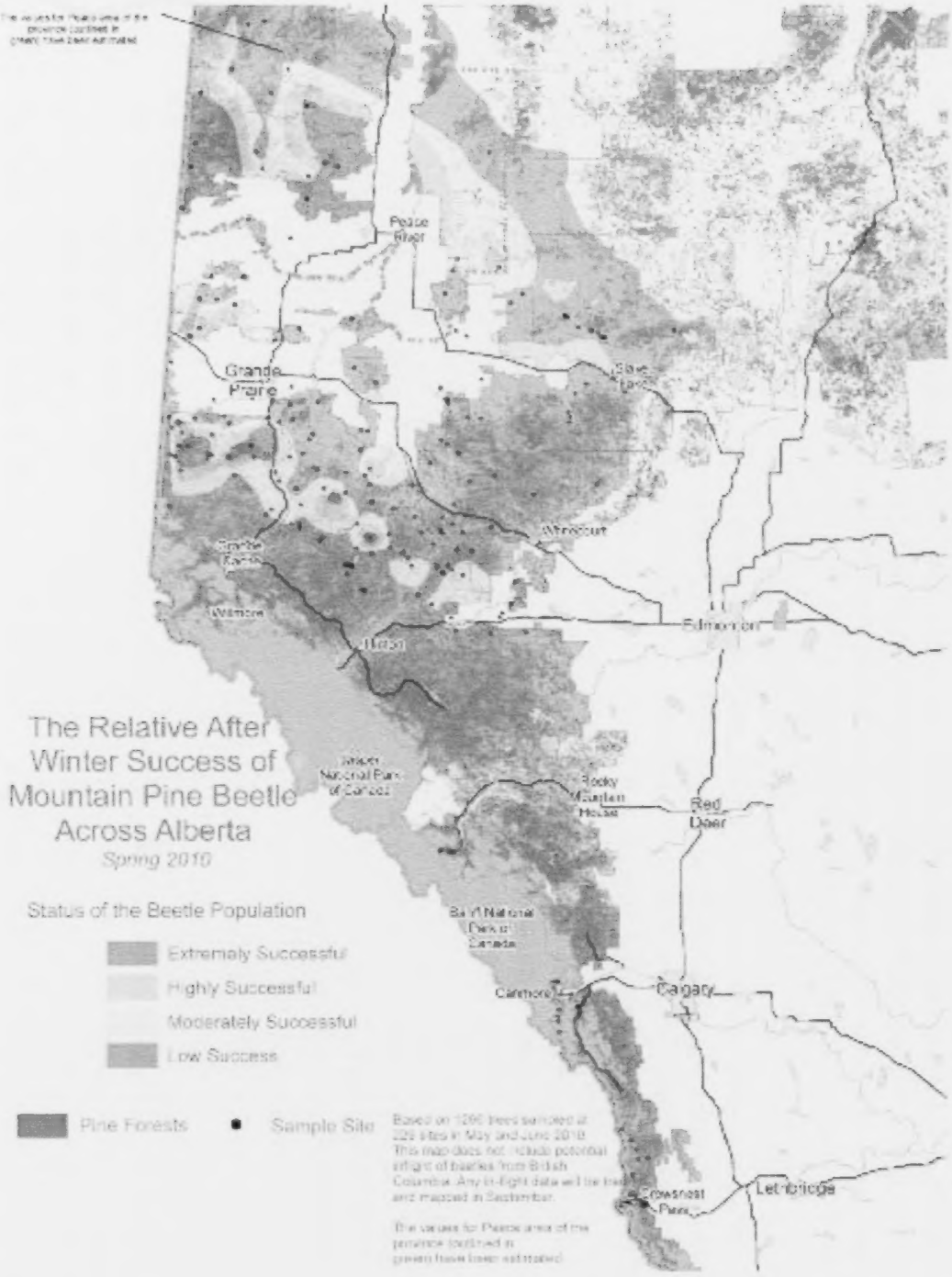


Figure 6.
Forecast on MPB population trends based on results of r-value surveys conducted in spring 2010 in Alberta.

Based on r-values, low success of MPB populations was projected in the North Saskatchewan and South Saskatchewan LUF regions in southwest Alberta; patches of moderate to highly successful MPB populations were projected in the Upper Peace and Lower Peace LUF regions. The MPB populations were projected to be extremely successful in areas south of Grande Prairie in the Upper Peace LUF Region and areas west of Highway 35 north of the Town of Peace River in the Lower and Upper Peace regions (Figure 6). Based on these results, MPB population growth was expected to be higher in 2010 in the Upper Peace and Lower Peace LUF regions.

MPB Control Program

Two control strategies were used to achieve the objectives of the provincial mountain pine beetle management program.

I. Beetle-focused Strategy to reduce MPB populations in infested areas in the short-term

II. Healthy Pine Strategy to reduce amount of MPB-susceptible pine trees across the province in the long-term

Refer to the "*Mountain Pine Beetle Management Strategy*" (Alberta Sustainable Resource Development, 2007a) for details on these strategies.

A Decision Support System (DSS), supported by Geographical Information System (GIS), was formulated to prioritize MPB-infested areas for control under the Beetle-focused Strategy. This system helps forest managers in deciding which areas are to be treated to meet provincial objectives. This DSS, based on beetle biology and risk of spread, was used to categorize beetle-infested stands into five levels of priority varying from very low; low; moderate; high to extreme (Alberta Sustainable Resource Development, 2007a). The DSS was further refined by making use of high green: red ratios that indicated potential beetle immigration. Those stands with MPB immigration were elevated into higher rankings with high control priority despite having low r-values and/or low numbers of infested trees.

Burning beetle-infested logs

In the Decision Support System, sites with higher r-values received higher priority in surveys and treatment. Those sites with the highest 25 per cent of r-values were placed in the high classification; those with the lowest 25 per cent in the low classification, and those with the remaining r-values were placed in the medium classification.

The number of infested trees in a patch was taken into account in prioritizing it for control. In the Leading Edge Zone patches with >3 trees were prioritized. The Leading Edge Zone contains small patches of infested trees with the ability to spread eastward. In the Holding Zone, (which contains larger patches of infested trees) patches with >25 trees were prioritized for survey and treatment. (The 2010 MPB management zones are shown in Figure 7 on page 16.)

The stand susceptibility index (SSI) – based on the percent, age and size of pine, together with climatic suitability to MPB – was used to classify stand susceptibility to the MPB. SSI was used to prioritize stands for control action.

The connectivity, a relative measurement of the proximity of MPB-susceptible stands in a defined area, was also taken into account in determining control action. The areas where MPB consistently undergoes a two-year life cycle (as determined by MPB degree-day requirement) were excluded from the treated area.

Each MPB site in the province was ranked based on the DSS. In the Leading Edge Zone (see below) all the sites with extreme, high and moderate rankings were surveyed and treated; in the Holding Zone all the sites with extreme and high rankings were surveyed and treated; and, in the Inactive Holding Zone SRD did not carry out either surveys or control actions.

Under the "Beetle-focused Strategy," 258,257 beetle-infested trees were treated in the 2010 beetle year. Out of these, 158,970 beetle-attacked trees were either felled and burned or chipped by SRD crews or contractors; another 99,287 infested trees were peeled, while they remained standing, to remove beetles. The details of this control program are shown in Table 1.

In addition, several municipalities removed 2,797 MPB-infested trees under an SRD grant program. The number of pine trees removed under this program by each municipality is shown in Table 2.

Table 1.
The number of beetle-infested pine trees that were removed under SRD's MPB control program in the 2010 beetle year in Alberta.

Corporate Area	Standing Peel	Felled and burned or chipped
Southern Rockies	8,879	5,743
Clearwater	44	2,513
Foothills	2,948	4,511
Woodlands	41,725	41,561
Smoky	38,942	86,265
Lesser Slave	6.749	18,377
Total	**99,287**	**158,970**

Under the Healthy Pine Strategy, 22 forest companies and individual operators harvested 3,605,624 cubic metres of mature pine from stands with high MPB risk.

In summary, the results of the 2010 MPB control program show that the Forest Health Program met Strategy 2.2 under SRD Business Goal 2, i.e., *"..... implement pre-emptive strategies to promote public safety, maintain forest health and manage infestations of disease, invasive plants and insect pests, such as the mountain pine beetle."*

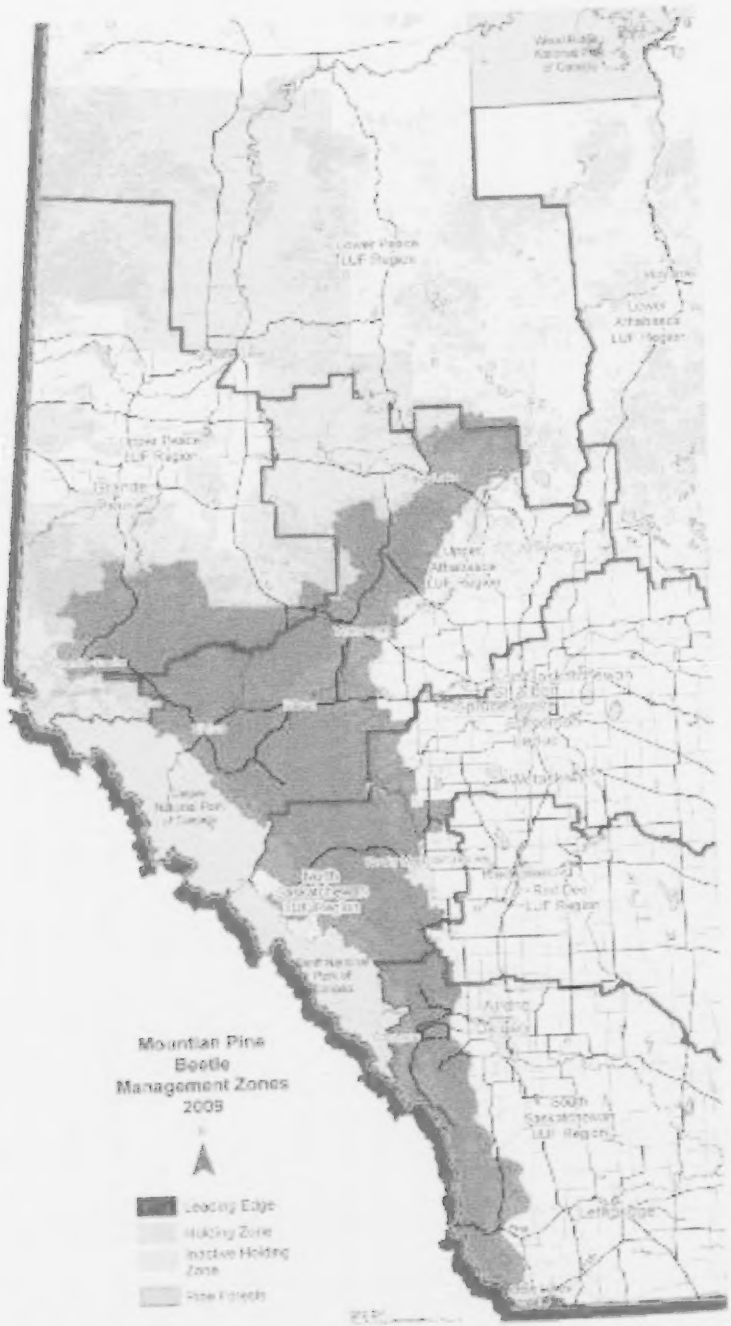


Figure 7.
MPB management zones in Alberta in the 2010 beetle year.

Table 2.
The number of MPB-infested trees removed by municipalities under SRD's grant program in the 2010 beetle year in Alberta.

Corporate Area	Municipality	# of pine trees removed	
		2009	2010
Smoky	Valleyview	----	96
	South Peace Municipalities	95,345	----
	City of Grande Prairie	242	----
Woodlands	Whitecourt	----	52
	Fox Creek	----	175
	Woodlands County	----	49
Southern Rockies	Canmore Corridor	739	167
	MD of Crowsnest Pass	974	1,608
	MD of Ranchland	----	38
	MD of Bighorn	12	----
Foothills	Edson	----	28
	Yellowhead County	----	584
	Town of Grande Cache	71	----
Peace	Town of Peace River	693	----
Lesser Slave	MD of Big Lakes	1,789	----
Total		**99,865**	**2,797**

Outlook for 2011

In 2011, MPB range will extend into pure jack pine stands in the boreal forest. The long-distance aerial dispersal baiting program carried out in July-September 2010 indicated long-distance dispersal of MPB into the Lower Athabasca LUF Region (Figure 8). Aggregation pheromone-baited trees in Waterways and Lac La Biche areas had beetle attacks; some sites had spill-over attacks as well. Genotyping of these MPB-infested jack pine samples collected from the Lac La Biche Area confirmed that, for the first time, MPB were detected in genetically-pure jack pine growing under natural conditions in the boreal forest (Janice Cooke).

In 2011, there will be a decline in the number of MPB-attacked pine trees especially in southern Alberta. Figure 9 shows spatial distribution of pine trees with red crowns, symptomatic of MPB attacks, in areas covered during heli-GPS surveys carried out in fall 2010. These results show potential decline in the number of MPB-attacked pine trees in Alberta. This declining trend was particularly noticeable in southern Alberta where relatively few pine trees with red crowns suspected of MPB attacks were detected. These results confirmed declining trends observed in r-value plots. In those areas of the Upper and Lower Peace LUF regions, where high r-values were found, MPB populations will continue to thrive in 2011, barring occurrence of unforeseen conditions that are unfavourable to MPB.

Figure 8.
Results of the MPB long-distance aerial dispersal baiting carried out from July to September 2010 in Alberta.

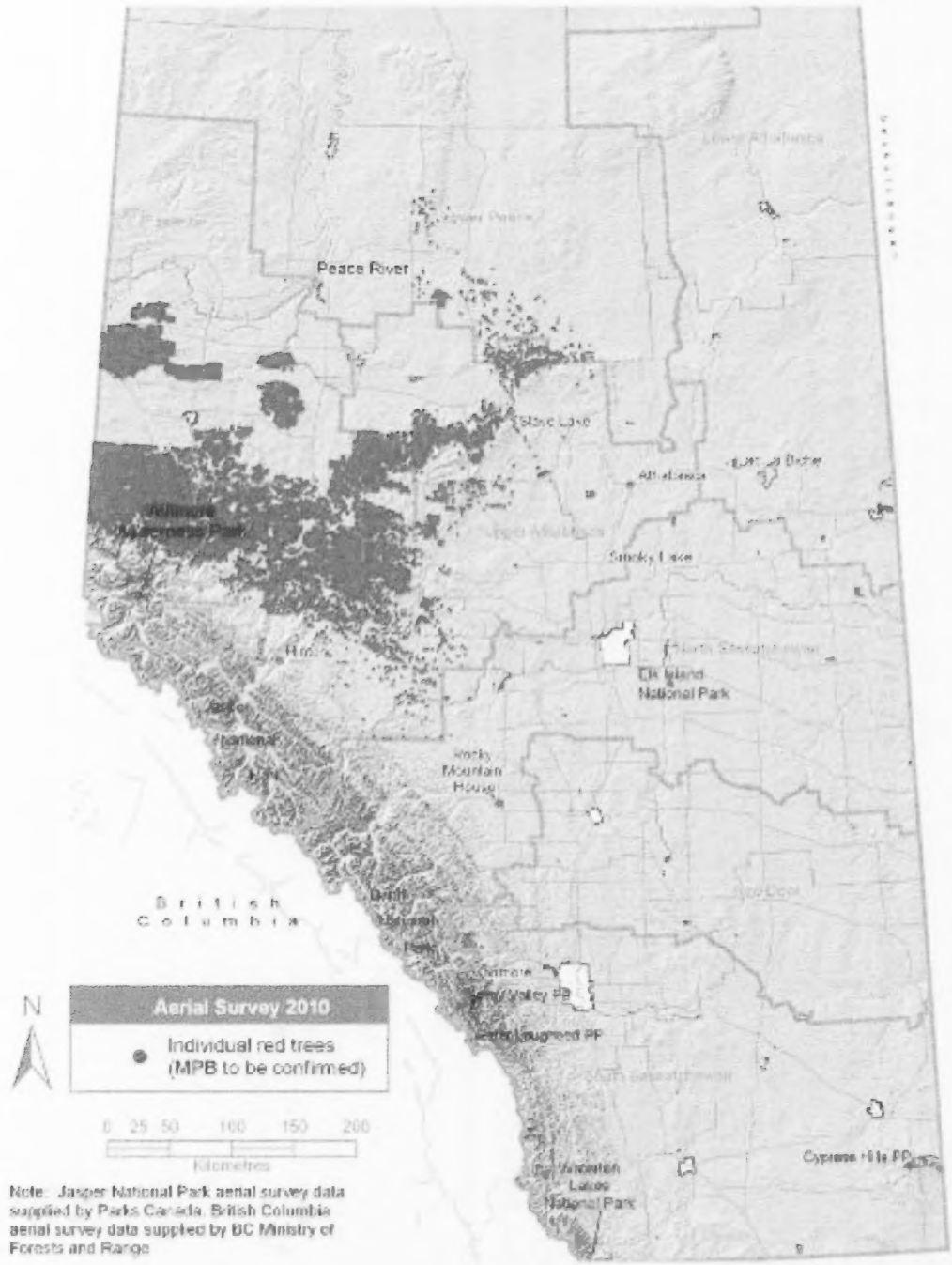

Peace River
Slave Lake
Athabasca
Wilmore Wilderness Park
Smoky Lake
Elk Island National Park
Jasper National Park
Rocky Mountain House
British Columbia
Aerial Survey 2010
Individual red trees (MPB to be confirmed)
N
0 25 50 100 150 200
Kilometres
Note: Jasper National Park aerial survey data supplied by Parks Canada. British Columbia aerial survey data supplied by BC Ministry of Forests and Range

Figure 9.
Distribution of pine trees with red crowns symptomatic of mountain pine beetle attacks in areas heli-GPS surveyed in September 2010, Alberta.

Spruce Budworm
Choristoneura fumiferana

Aerial Surveys

Each year, Forest Health Officers and/or Technicians carry out aerial surveys to monitor extent and severity of spruce budworm infestations on forested Crown land. The goals of this program are two-fold:

1. To keep a historical record of these infestations, and,
2. To assess the need to take management actions if spruce budworm infestations compromise management objectives of the affected lands.

The aerial survey methods used in these surveys are described in "Forest Health Aerial Survey Manual" (Ranasinghe and Kominek, 1998).

The results of these surveys are shown in Figure 10 and in Table 3.

Overall, spruce budworm defoliation in the surveyed area of the province increased by 60 per cent in 2010 (Figure 10) compared to that in 2009 (Figure 11). There was a modest 15 per cent decline in the moderately (35 per cent to 70 per cent of current year foliage) defoliated area. In contrast, severely (over 70 per cent of current year foliage) defoliated area increased almost two-fold.

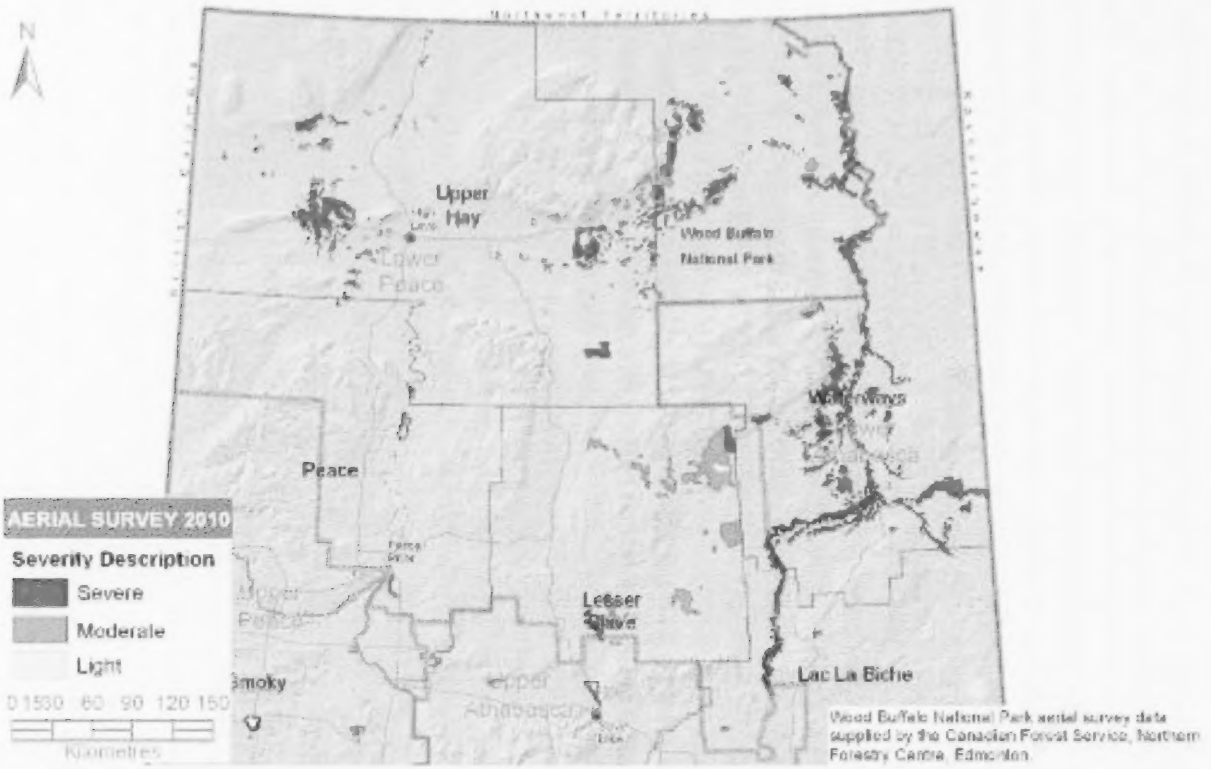


Figure 10.
Spatial distribution of aerially visible spruce budworm defoliation over Alberta's forested Crown land surveyed in 2010.

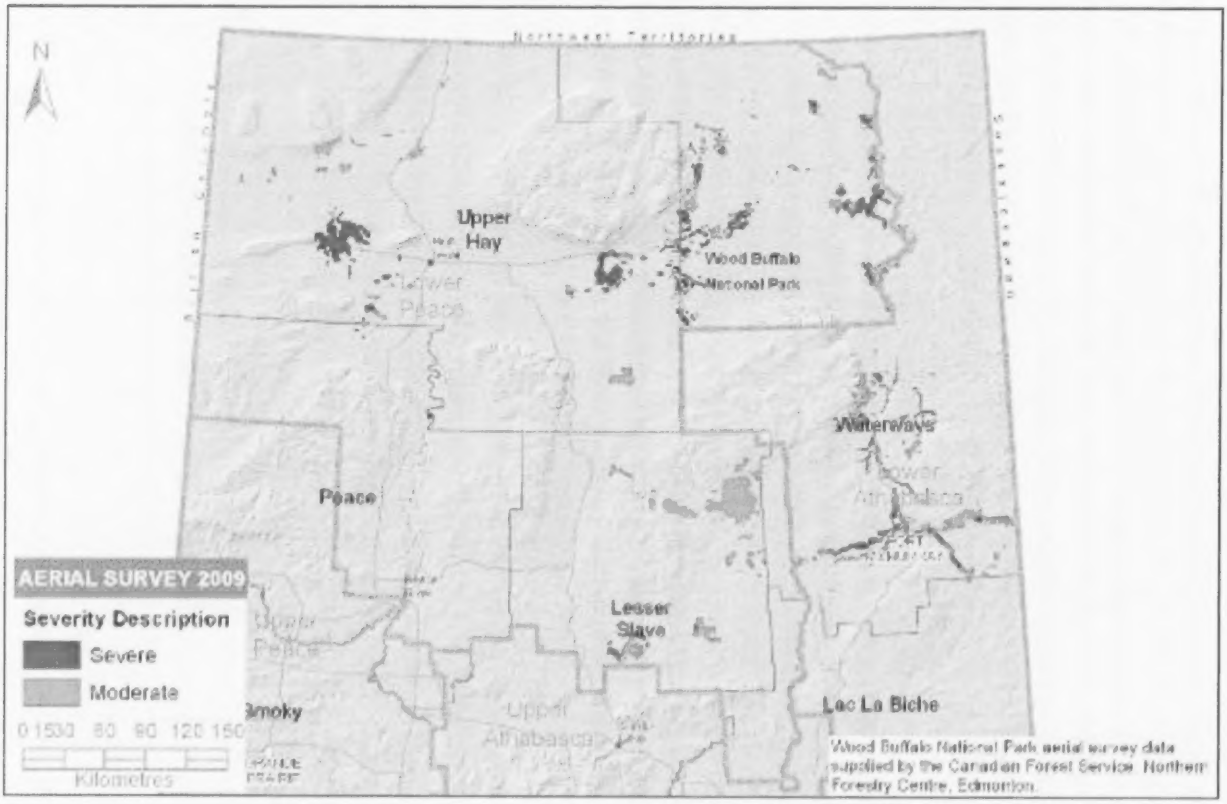


Figure 11.
Spatial distribution of aerially visible spruce budworm defoliation on forested Crown land surveyed in Alberta in 2009.

Table 3.
The number of hectares with spruce budworm defoliation recorded, under each severity category, during aerial surveys carried out in Alberta[1] in 2009 vs. 2010.

	Moderate	Severe	Total
2009	107,430	60,431	167,861
2010	90,780	178,585	269,365
Change[2]	-15 per cent	196 per cent	60 per cent

[1] Excluding Wood Buffalo National Park data

[2] Percent change in the area defoliated in 2010 compared to the corresponding area in 2009

The extent of spruce budworm defoliated areas in each Land-use Framework (LUF) region is shown in Table 4.

Table 4.
The extent and severity of defoliation recorded in the Land-use Framework regions infested with spruce budworm in 2010, Alberta.

LUF Region	Corporate Area/s	Extent of Defoliation (ha)		Total
		Moderate	Severe	
Lower Athabasca	Lac La Biche Waterways	3,318	95,575	98,893
Upper Athabasca	Lac La Biche	1,838	308	2,146
Lower Peace	Lac La Biche Lesser Slave Peace Upper Hay Waterways	85,624	82,702	168,326
Sub-Total		**90,780**	**178,585**	
Grand Total				**269,365**

The five-year trend in spruce budworm defoliation in northeast Alberta, which includes the Lower Athabasca LUF Region, is shown in Figure 12. The declining trend in the extent of defoliation observed in this area reversed in 2010 with a dramatic increase in severity of defoliation. In the Lower Athabasca LUF Region, spruce budworm defoliation expanded by about 63 per cent compared to that in 2009. This is mainly due to an increase in the severely defoliated area from 16,991 to 95,575 hectares; the moderately defoliated area decreased from 43,583 to 3,318 hectares during this period.

In northwest Alberta, which includes the Lower Peace LUF Region and part of the Upper Athabasca LUF Region, there has been a steady increase in the extent of spruce budworm defoliation in the past five years (Figure 13). The current defoliation covers most of the areas defoliated during the last outbreak. In the Lower Peace LUF Region, there was a 57 per cent increase in the budworm defoliated area in 2010, compared to

Mature spruce budworm larva

that in 2009. The severely defoliated area increased by 90 per cent and the moderately defoliated area increased by 35 per cent, compared to those in 2009. Spruce budworm defoliation in the Upper Athabasca LUF Region remained relatively low at 2,146 hectares. Yet, compared to 297 hectares defoliated in 2009, this is a six-fold increase in the defoliated area. Most (86 per cent) of this defoliation was moderate and 14 per cent was severe.

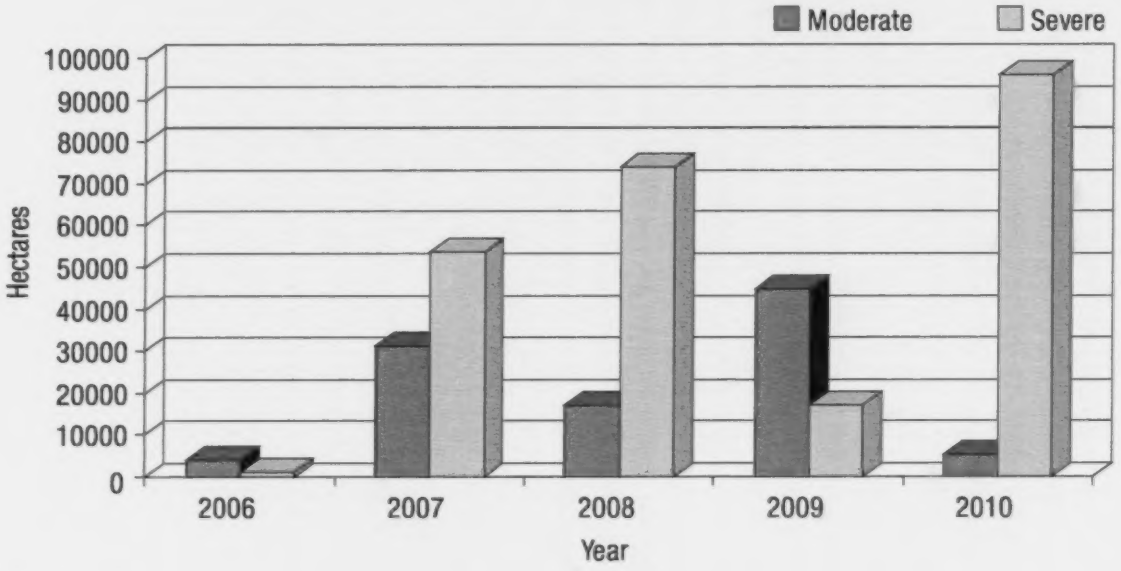


Figure 12.
The extent of moderate vs. severe spruce budworm defoliation in northeast Alberta, 2006–2010.

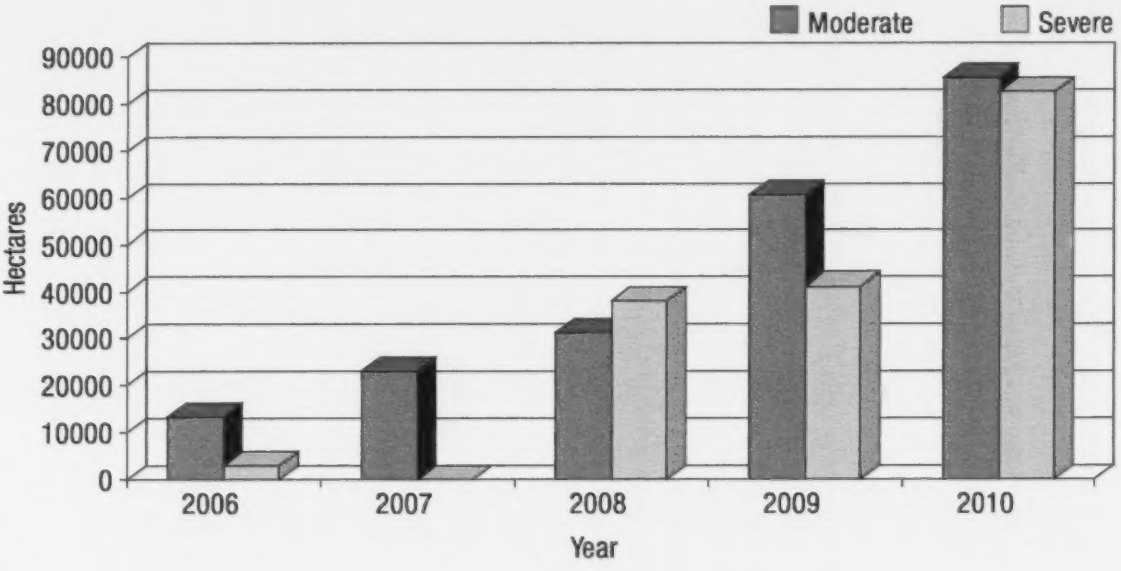


Figure 13.
The extent of moderate vs. severe spruce budworm defoliation in northwest Alberta, 2006–2010.

Forecast for 2011

Multipher-I® traps baited with synthetic lures of female spruce budworm sex pheromone are used annually to monitor male budworm moth population at strategically selected sites across forested Crown land. The procedure for deploying these traps is described in the *Spruce Budworm Management Guide* (Ranasinghe and Kominek, 1998). In 2010, two traps with lures were placed at each of the 160 trap sites located across the Green Area of the province. Surveys were completed at 154 of these sites. Figure 14 shows the forecasted risk based on the results of these surveys.

Based on pheromone-baited trap catches, 84 per cent of the monitoring sites in the Lower Athabasca LUF Region (Waterways and Lac La Biche areas) had high risk of spruce budworm infestations occurring in 2011 (Appendix 1 - LUF embedded with Forest Areas). In this region, trap catches indicated high risk of infestations at 76 per cent of the 25 trap sites in the Lac La Biche Area and at 94 per cent of the 18 trap sites in the Waterways Area. Risk of infestations occurring in 2011 was moderate in 24 per cent of the plots in the Lac La Biche Area and six per cent of the plots in the Waterways Area. These results indicated that spruce budworm infestations were very likely to continue in the Lower Athabasca LUF Region in 2011. However, results of a limited egg mass survey carried out in this region in December 2010 by the Forest Health Officer, indicated that the extent and severity of budworm defoliation in 2011 is expected to be low. A second-instar (L2) survey carried out in 2011 January at 80 sites confirmed that spruce budworm infestations in this region will decline in 2011 with most defoliation occurring at light to moderate levels (Table 5).

In the Lower Peace LUF Region (Upper Hay, Peace and Lesser Slave areas) the risk of spruce budworm infestations occurring in 2011 is low to moderate at most trap sites. In the Upper Hay Area, risk of infestations occurring in 2011 was high at 20 out of 128 trap sites (15 per cent); moderate at 70 sites (55 per cent), low at 34 sites (27 per cent) and nil at four sites (3 per cent). In the Peace Area, risk of infestations occurring in 2011 was nil to light at all 19 trap sites; out of 19 trap sites in the Lesser Slave Area, risk is low at nine sites (69 per cent); moderate at three sites (23 per cent) and high at one site (8 per cent).

In the Upper Athabasca LUF Region, trap catches at all five sites in the Woodlands Area and at all twenty sites in the Foothills Area indicated low risk of new spruce budworm outbreaks occurring in 2011. In the North Saskatchewan LUF Region, out of the nine trap sites located in the Clearwater Area, trap catches at one site had no risk, at seven sites had low risk and at another site had moderate risk of new spruce budworm outbreaks occurring in 2011; the site with moderate risk is located at high elevation and likely to be inhabited by the two-year cycle budworm, *Choristoneura biennis*. In the South Saskatchewan LUF Region, out of the nine trap sites, eight had catches indicative of low risk and one had a trap catch indicative of moderate risk of spruce budworm outbreak occurring in 2011. This site with moderate risk is located at a higher elevation that is likely to be inhabited by the two-year cycle budworm (Figure 14).

Table 5.
Results of a second instar (L2) larval survey carried out in the Lower Athabasca LUF Region in January 2011.

No. of Plots	Range of L2 Counts Per 10 m^2 of foliage	Expected Severity of Defoliation in 2011
28 (35 per cent)	31 – 173	Light (<35 per cent)
38 (48 per cent)	193 – 526	Moderate (35-70 per cent)
14 (17 per cent)	543 – 1,983	Severe (>70 per cent)

Figure 14.
Forecast on risk of spruce budworm infestations occurring in 2011, based on male moth catches in pheromone-baited traps in 2010, Alberta.

Western Spruce Budworm
Choristoneura occidentalis

The western spruce budworm defoliated an estimated 2,893 hectares in the South Saskatchewan LUF Region in southwest Alberta. This is a drastic decline compared to 30,779 hectares defoliated by this pest in 2009. Defoliation severity was light over 787 hectares, moderate over 1,301 hectares and severe over 804 hectares (Figure 15).

Western spruce budworm damage

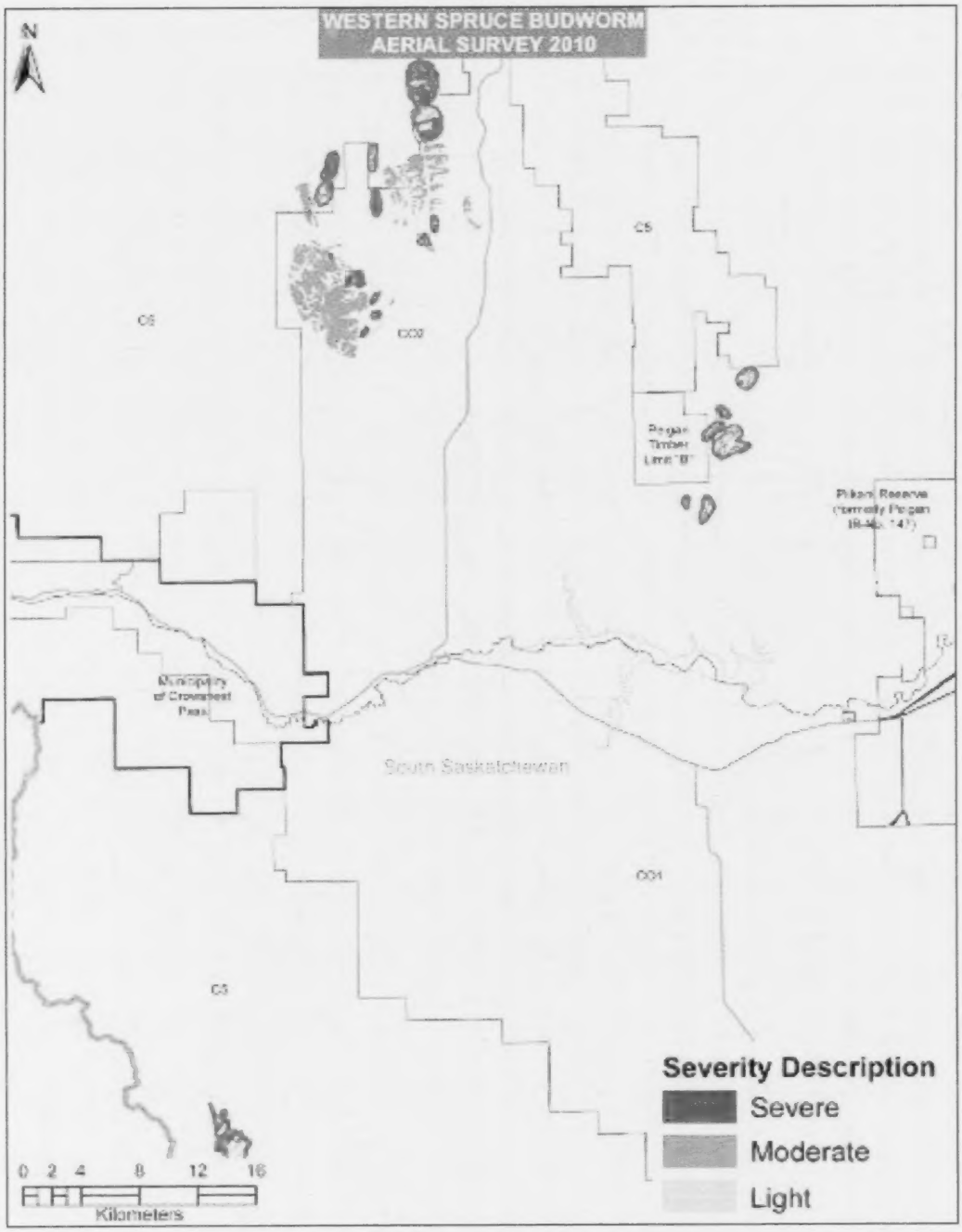


Figure 15.
Spatial distribution of western spruce budworm defoliated areas visible during aerial surveys carried out in 2010 summer in southwest Alberta.

Aspen Defoliators

Forest Health Officers and/or Technicians carry out annual aerial overview surveys to record the area over which aspen defoliation is scattered and to estimate the intensity of defoliation by severity categories. To carry out these surveys, the survey procedure described in the "*Forest Health Aerial Survey Manual*" (Ranasinghe and Kominek, 1998) was modified to include use of a tablet personal computer linked to a global positioning system. The objective of this exercise is to maintain a historical record of insect pest caused aspen defoliation in the "Green Area" of the province.

Figure 16 shows the results of these surveys. In 2010, aspen defoliation was scattered over an estimated 62,658 hectares. Most (97 per cent) of this defoliation was light (<35 per cent) and the remainder was moderate (35 – 70 per cent) in intensity. The extent and severity of 2010 aspen defoliation across the LUF regions are shown in Table 6. Upper Peace LUF Region had 80 per cent of aspen defoliation observed in 2010 over the Green Area; all of this defoliation was light in intensity. Lower Peace LUF Region had nearly 17 per cent of aspen defoliation, most (85 per cent) of which was light and the remainder was moderate in intensity. The remaining three per cent of aspen defoliation was distributed among the LUF regions of Lower Athabasca, Upper Athabasca and North Saskatchewan (Table 6).

Table 7 shows the extent of 2010 aspen defoliation that was attributed to different pest species. Bruce spanworm (*Operophtera bruceata*) was the predominant defoliator causing 50,765 hectares (81 per cent) of 2010 aspen defoliation. Almost all (99.6 per cent) of this defoliation was light. The forest tent caterpillar (*Malacosoma disstria*) defoliated 10,333 hectares (16.5 per cent) of observed damage in 2010. Out of this damaged area, 85.2 per cent was light and 14.8 percent was moderate. The large aspen tortrix (C. *conflictana*) damage was confined to 1,561 hectares (2.5 per cent) most of which (87.7 per cent) was light and the remainder was moderate in intensity.

Figures 16, 17 and Table 8 show comparison of the extent and severity of aspen defoliation in Alberta between 2009 and 2010. In 2010, there was a further decline in the extent of aspen defoliation to 62,658 hectares compared to 207,243 hectares over which aspen defoliation was scattered in 2009. In 2010, light aspen defoliation was observed over 60,725 hectares compared to that of 181,000 hectares observed in 2009. Moderate defoliation was reduced to 1,933 hectares in 2010, compared to 26,243 hectares moderately defoliated in 2009.

Figure 16.
Spatial distribution of aerially-visible aspen defoliation by severity categories in areas surveyed in 2010, Alberta.

Figure 17.
Spatial distribution of aerially visible aspen defoliation by severity categories in areas surveyed in 2009, Alberta.

Table 6.
The extent of forest insect caused aspen defoliation in 2010, by severity categories, in Land-use Framework regions of Alberta[1]

LUF Region	Gross Area of Defoliation (ha)			
	Light	Moderate	Severe	Total
Lower Athabasca	507	184	0	**691**
Upper Athabasca	944	162	0	**1,106**
Lower Peace	8,939	1,528	0	**10,467**
Upper Peace	50,327	0	0	**50,327**
North Saskatchewan	8	0	0	**8**
South Saskatchewan	0	59	0	**59**
Total	**60,725**	**1,933**	**0**	**62,658**

[1] Excluding Wood Buffalo National Park and Prairies

Table 7.
The extent of forest insect caused aspen defoliation in 2010 by pest species, Alberta1 [1]

Pest	Light	Moderate	Severe	Total
Bruce Spanworm	50,603	162	0	**50,765**
Forest Tent Caterpillar	8,805	1,528	0	**10,333**
Large Aspen Tortrix	1,317	243	0	**1,560**
Total	**60,725**	**1,933**	**0**	**62,658**

[1] Excluding Wood Buffalo National Park and Prairies

Table 8.
The extent and severity of aspen defoliation by the Land-use Framework regions in Alberta, 2009 vs. 2010

LUF Region	Defoliation Severity 2009			TOTAL 2009	Defoliation Severity 2010			TOTAL 2010
	Light	Moderate	Severe		Light	Moderate	Severe	
Lower Athabasca	83,621	1,525	0	85,146	507	184	0	691
Upper Athabasca	23,628	106	0	23,734	944	162	0	1,106
Lower Peace	8,662	66	0	8,728	8,939	1,528	0	10,467
Upper Peace	16,777	1,238	0	18,015	50,327	0	0	50,327
North Saskatchewan	267	0	0	267	8	0	0	8
South Saskatchewan	48,045	23,308	0	71,353	--------	59	--------	59
Total	**181,000**	**26,243**	**0**	**207,243**	**60,725**	**1,933**	**0**	**62,658**

2010 Invasive Plant Species Program

Introduction

In 2010, Forest Health regional staff took a proactive approach to invasive plant management issues. Following provincial directives, this approach allowed for more localized involvement and commitment leading to more field level control efforts.

This year, the following provincial mandates were fulfilled under this program:

- survey and control of invasive plants on both SRD occupied sites and on vacant Crown land;
- initialization and/or continuation of localized weed (invasive plant) cooperative plans within designated areas with high value and high probability of success;
- early detection and rapid response to invasive plants that occur in relatively clean and/or previously un-infested areas on vacant public land, targeting high value sites and high risk plant species; and
- on going education and awareness initiatives.

Invasive Plant Detection, Surveys and Distribution

For the first time, spotted knapweed (*Centaurea stoebe*) was noted in the Clear Hills County in 2010; this is most likely the first recording of this prohibited noxious species within the Peace River Area. As well, creeping bellflower (*Campanula rapunculoides*) and bladder campion (*Silene cucubalus*) were found for the first time in the Clearwater Forest Area in the North Saskatchewan LUF Region.

SRD owned and occupied sites surveyed in 2010 included fire lookout tower sites, Sacramento gauges, fire bases, recreation areas, gravel pits, office sites as well as vacant Crown land such as random camp sites, abandoned forestry roads and quad trails.

Spotted knapweed

Figures 18-23 show occurrence of six prominent invasive plant species in 2010, in relation to their historic survey information. Canada thistle, tall buttercup, and oxeye daisy were the predominant invasive plant species in the province in 2010.

Canada Thistle

Figure 18.
Distribution of Canada thistle in 2010 in relation to its historical occurrence at SRD survey sites in Alberta.

Common Tansy

Figure 19.
Distribution of common tansy in 2010 in relation to its historical occurrence at SRD survey sites in Alberta.

Scentless Chamomile

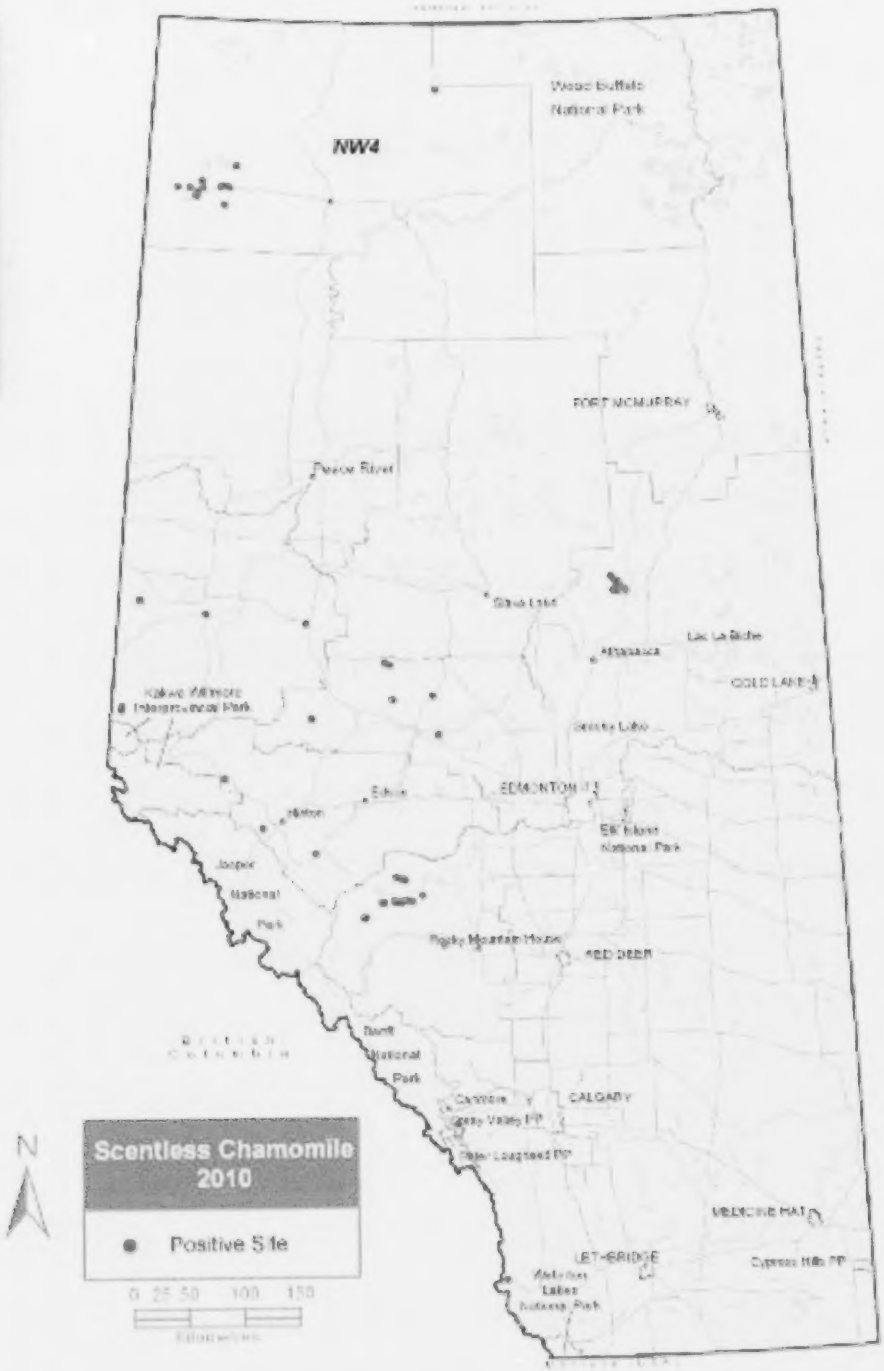
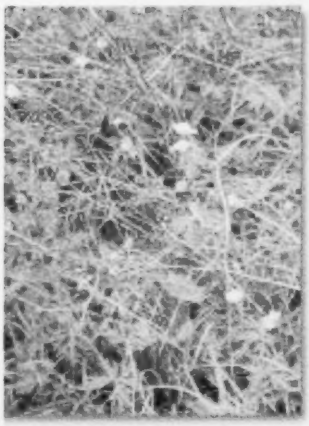
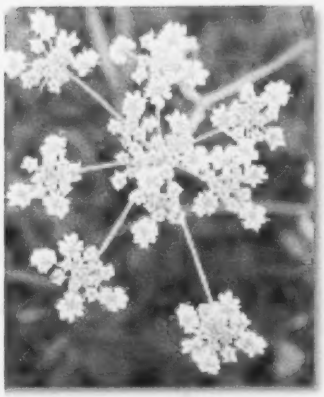


Figure 20.
Distribution of scentless chamomile in 2010 in relation to its historical occurrence at SRD survey sites in Alberta.



Tall Buttercup

Figure 21.
Distribution of tall buttercup in 2010 in relation to its historical occurrence at SRD survey sites in Alberta.



Wild Caraway

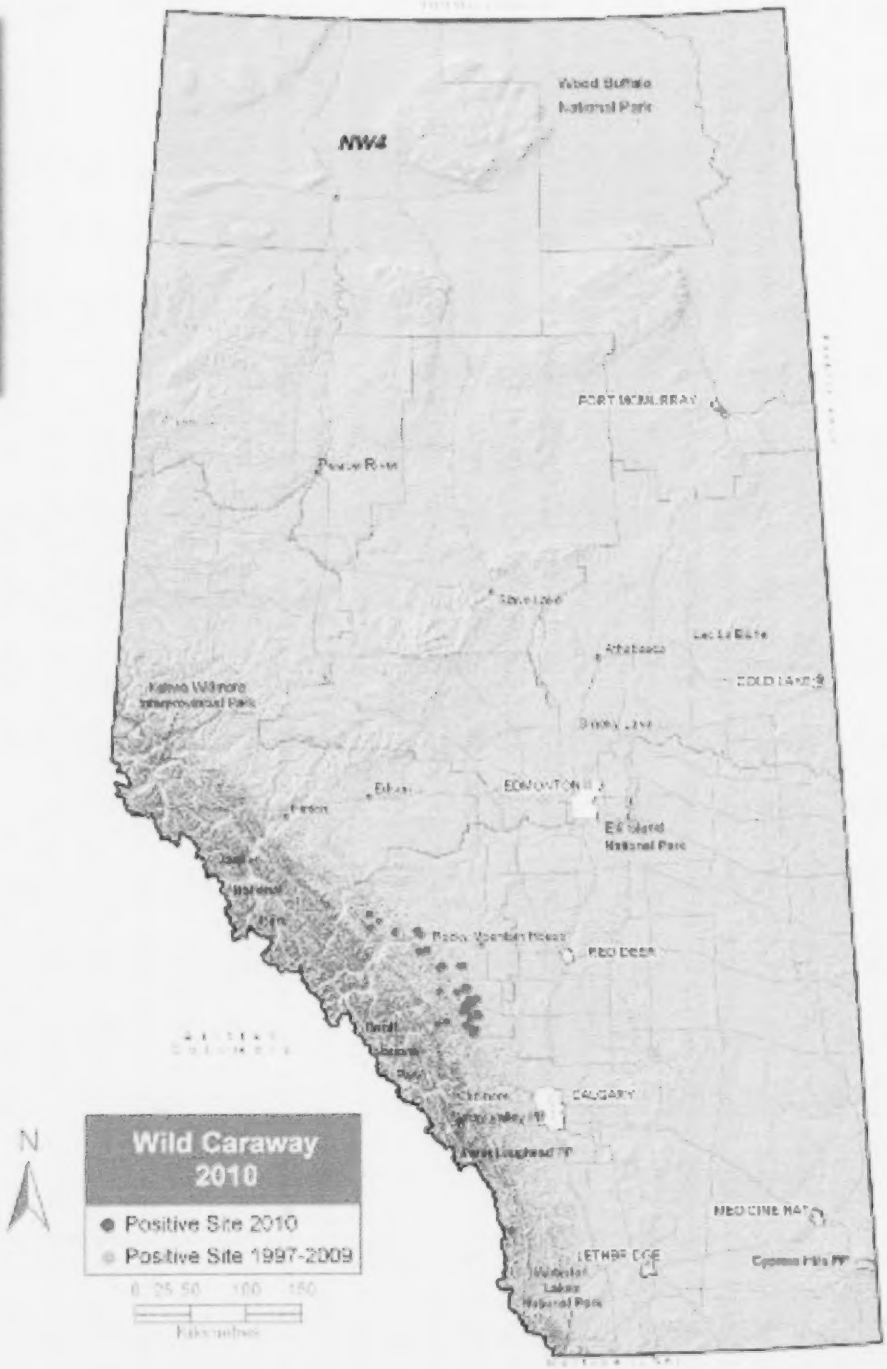


Figure 22.
Distribution of wild caraway in 2010 in relation to its historical occurrence at SRD survey sites in Alberta.

Oxeye Daisy

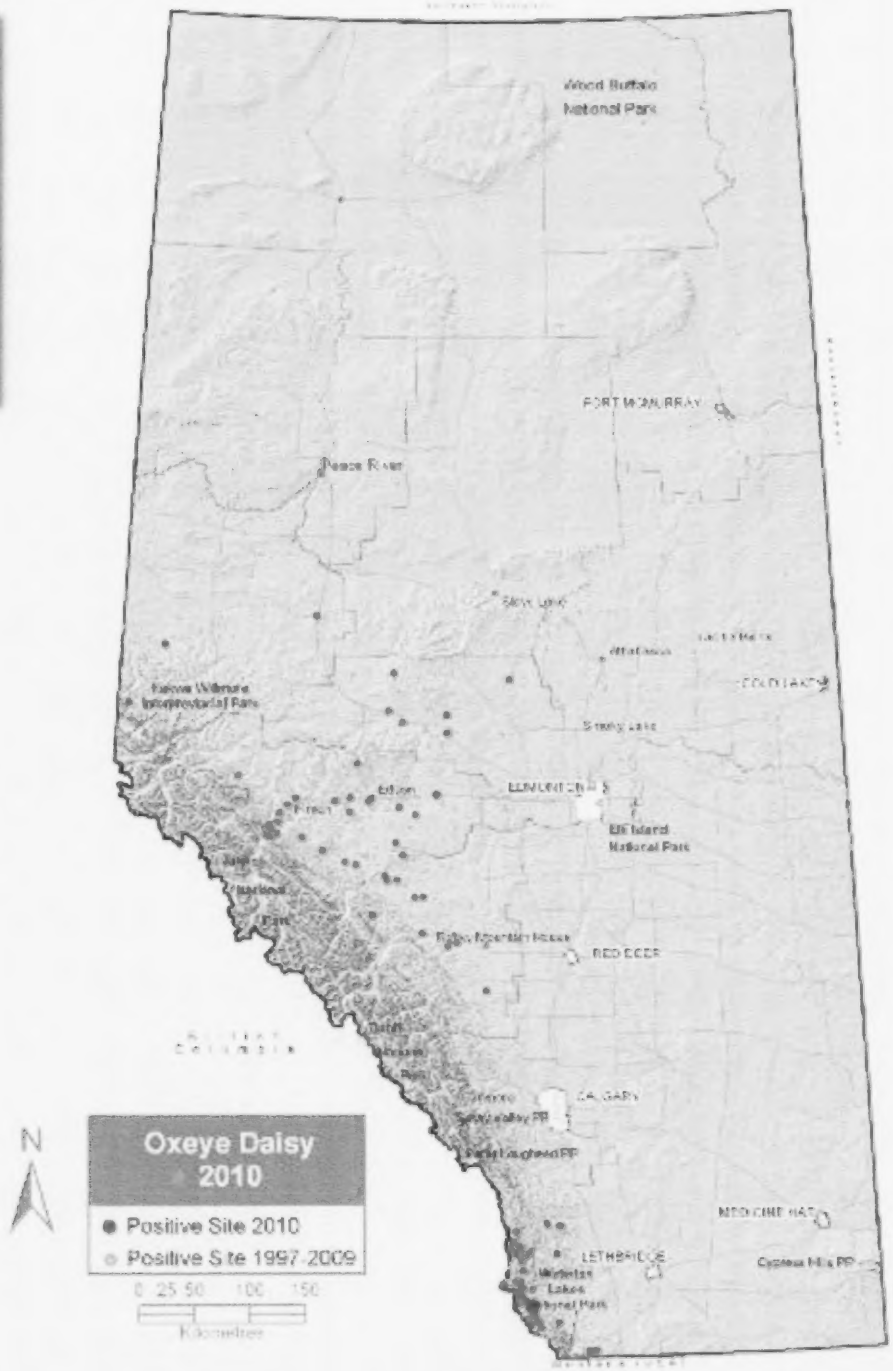


Figure 23.
Distribution of oxeye daisy in 2010 in relation to its historical occurrence at SRD survey sites in Alberta.

Invasive Plant Management

The Municipal District (MD) of Pincher Creek issued SRD a weed inspector's notice for four different invasive plant species found on vacant Crown land. Consequently, a widespread invasive plant survey inventory was completed in most major drainages found on public lands. This survey focussed on detecting and controlling Dalmatian and yellow toadflax, blueweed, and spotted knapweed as per the weed notice. The vacant Crown lands treated were primarily recreation sites such as random campsites, abandoned forestry roads, and quad trails.

In 2010, backcountry infestations reported by guardians were controlled in the Blackstone and Vimy areas. Backpack sprayers were used to control tall buttercup, oxeye daisy, white cockle, and wild caraway around camp sites as well as along trails.

During an inspection of the Fox Creek Ranger Station (Woodlands Forest Area), oxeye daisy, common tansy, tall buttercup, and a large area of scentless chamomile were discovered. This area was flagged for control as there was great potential for a serious invasion due to heavy traffic at this site. Re-assessment of control success at this site will be carried out over the next two years.

All co-operative spray projects planned and organized by SRD for the 2010 season were successful. For example, in the Clearwater Area, a four-year cooperative project between SRD and Sundre Forest Products is significantly reducing wild caraway populations. Other successful weed co-ops include the Amadou and Yellowhead County; various memorandums of understanding (MOUs) have been signed with the MDs of Ranchland, Crowsnest Pass, and Willow Creek in the Southern Rockies Area.

For the Amadou Weed Cooperative initiative 2010 was another successful year. The Amadou area was selected as a potential area for an invasive plant management cooperative in 2007. In this area, scentless chamomile, among other noxious weed species, had spread to epidemic levels along roads, dispositions, cutlines and cutblocks. The responsibilities of invasive plant control within the Amadou Weed Co-op have been divided among the cooperative partners. Partners such as Husky Energy, Alberta-Pacific, Vanderwell and SRD once again conducted various mechanical and chemical weed control methods within the target area during the 2010 season. As well, weeds at most priority sites from 2009 were re-visited and controlled, as necessary. Overall, the number and extent of weeds in this area has decreased substantially due to cumulative efforts of various partners involved since this venture began. Although, certain pipelines, quad trails, and old cut-block roads still harbour weeds, these areas are scheduled for targeting in 2011. The main entrance sign at the Amadou Weed Co-op area, meant for educating recreational users and local stakeholders, was erected in 2010.

Yellowhead County and SRD joined forces once again this year to promote invasive plant awareness. They focussed mainly on education and developing relationships with various stakeholders and the public. Some of the major stakeholders involved include Hinton Wood Products, CN Rail, Grazing Associations, Alberta Transportation, Alberta Infrastructure and Alberta Tourism, Parks and Recreation, Fire-smart Project Areas and various oil and gas companies. During this year's *Brule Pull a Weed Day*, various groups including Yellowhead County and SRD staff, Junior Forest Rangers, and members of the public got together to hand pull over 400 kilograms of invasive plants near water bodies, in one day. Overall, this day also provided a great opportunity to speak about herbicides, mechanical control, and invasive plants identification.

Further collaboration and cooperation regarding invasive plant issues were observed in the Southern Rockies with the MDs of Willow Creek and Crowsnest Pass signing an MOU. All objectives were completed within the specific areas outlined by SRD.

Overall, information and work sharing programs have been met with the common goal of eradication, mitigation, education, prevention and cooperation of control work within municipal and SRD boundaries.

Education and Public Awareness

Various invasive plant education and outreach activities were attended and/or organized by SRD. These included invasive plant meetings and gatherings, information booths to promote invasive plant co-operatives and demonstrations to the public on importance of controlling invasive plants. For example, at last year's William A. Switzer Parks day in Hinton, the invasive plant booth that was set-up was visited by over 300 members of the public.

In 2010, the Government of Alberta Interdepartmental Invasive Alien Species Working Group was involved in organizing an Invasive Plant Management course at the Hinton Training Centre. Twenty-nine people attended the course entitled *Ecological Approaches to Invasive Plant Management* presented by Dave Polster from British Columbia. Overall, this course led to extensive discussions around the concept of successional advancement, i.e., using various ecological approaches without having to rely on chemical means of control.

SRD also hosted its 5th Annual Northeast Alberta Invasive Plant Workshop in Athabasca, co-hosted for the first time with the County of Athabasca. This workshop is organized by SRD's Cooperative Invasive Plant Working Group for the Waterways/Lac La Biche Area. A record number of 102 participants representing the oil and gas industry, forest product companies and consulting firms attended this event. With a large number of guest speakers and a variety of interactive activities, the 2010 workshop was a tremendous success. The presentations this year included invasive plant identification, biology, and management options; new weed introductions; new and upcoming control products; biological control update; seed analysis; and benefits of cooperative weed management. Continuing competency credits were earned by members of the College of Alberta Professional Foresters (CAPF), the College of Alberta Professional Forest Technologists (CAPFT), and certified pesticide applicators that were in attendance.

INVASIVE PLANTS
A field of scentless chamomile may look pretty to some—but don't be fooled. It is not a wildflower—it's an invasive plant that can outcompete native vegetation and impact wildlife habitat, which can damage our natural ecosystems. Learn about invasive plants and how you can help keep our wildlands natural.
invasiveplants.ab.ca
HELP STOP THE SPREAD
Avoid disturbing ground cover and stay on designated trails.
Clean plants, seeds and mud from vehicles, equipment, clothing and pets.
Use "weed free" feed for horses 2-3 days prior to and during your back-country trip.
Government of Alberta

Invasive Plant Awareness Sign

Following much design consultation and draft approvals, new invasive plant awareness signs were created for the forest areas. These signs are targeting different invasive plant species in different areas. An overall provincial message conveying the risk of spreading invasive plants through various means such as recreational activities is depicted on these signs.

Forest Health staff provided information packages and answered questions while attending several projects on hand pulling of invasive plants.

Data Management

The control contractors in the Clearwater Forest area supplied all their control data in digital format, on an experimental basis, as requested by the invasive plant coordinator. All data were submitted as shape-files containing the required information. Data collection in digital format will be added to the 2011 contract.

Plans for 2011 Season

Activities planned for 2011 field season include controlling new infestations at SRD sites. In 2011 summer, some areas will follow an ecological approach to controlling invasive plants by using species specific methods such as biological control and successional advancement techniques. For the first time, SRD plans on trying willow staking to combat the scentless chamomile infestation in a gravel pit in the Amadou Weed Cooperative area. This area will be ripped up to create a rough and loose surface that will be planted with willows in 2011 spring; over time, willows are expected to choke out the weeds by successional advancement. As well, some areas may require manual pulling due to their proximity to watersheds. All sites treated in 2010 will be followed up in 2011 summer to determine the efficacy of control efforts; these invasive plants will be controlled again, if necessary. Re-inspections will ensure compliance of sites that were surveyed in 2009 and re-inspected in 2010.

Strengthening cooperative management relationships between industry and municipalities throughout the province is on-going. The goals for 2011 include increasing public awareness of invasive plant species through events such as trade shows, open houses, 'pull a weed' days, school talks, information sessions, and by increasing signage in recreation and heavy-used areas throughout the province. As well, the issue of weed-free feed for horses will be re-visited with backcountry equestrians.

Furthermore, discussions will continue and plans will be made to move toward a more focussed direction to achieve positive results (low risk of re-infection, high value sites, etc). Priority activities will also be discussed where the likelihood of success is high, and/or the activity has proven effective.

Other Noteworthy Pests

Lodgepole pine dwarf mistletoe, (*Arceuthobium americanum*)

A light infestation of lodgepole pine dwarf mistletoe was observed over an estimated gross area of 7,544 hectares in the Upper Athabasca LUF Region.

Armillaria Root Disease, (*Armillaria* spp.)

Armillaria disease centres extending over 164 hectares were observed in the South Saskatchewan LUF Region.

Abiotic Forest Health Damaging Agents

Extensive hail damage was reported from the Upper Athabasca and North Saskatchewan LUF regions in 2010. Typically hail damage occurs in localized areas of Alberta during months of July and August. However, hail damage that was surveyed in 2010 was much more extensive. This hail storm most likely occurred in August 2009. During 2010 annual aerial surveys carried out in June, hail damage was observed over a wide area 190 kilometres long in the South Saskatchewan, North Saskatchewan and Upper Athabasca LUF regions. Some hail-damaged patches were as long as 40 kilometres. Detailed, rotary-wing aerial surveys carried out September 2010 detected hail damage over an estimated 914 hectares in the

South Saskatchewan LUF Region, 26,163 hectares in the North Saskatchewan LUF Region and 18,901 hectares in the Upper Athabasca LUF Region (Figure 24). The hail damage was more severe on regenerating trees. The Forest Health Section will establish monitoring plots to study the long-term impact of this hail damage.

During aerial surveys, trees affected by water-logging, storm damage and red-belt were observed in the Upper Athabasca LUF Region (Foothills Area).

Drought-caused tree decline and tree kill were observed over an estimated 45,056 hectares in the Upper Peace LUF Region. Drought damage was light over 128 hectares of Alpine fir and light to moderate over 624 hectares of willow in the South Saskatchewan LUF Region. In this region, an estimated 6,321 hectares of aspen had die back perhaps due to drought; die back was light over 5,038 hectares, moderate over 941 hectares and severe over 342 hectares.

Red belt was observed over an estimated 345 hectares in the South Saskatchewan LUF Region. In this region, blow down was light over an estimated 8,591 hectares, moderate over 9 hectares and severe over 4 hectares.

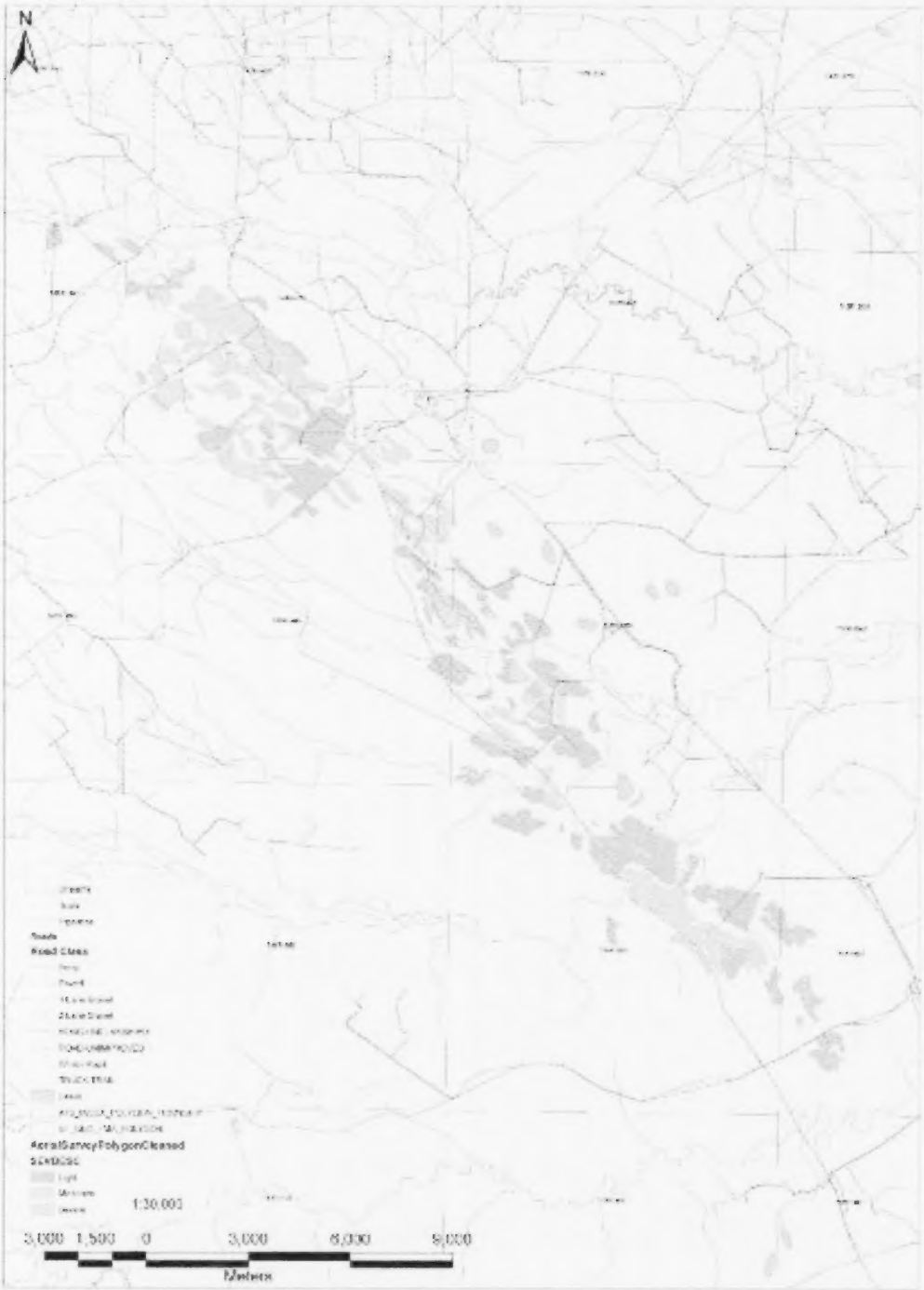


Figure 24.
A map showing the extent of damage by severity categories following a severe hail storm that likely occurred in August 2009, in southwest Alberta.

Collaborative Pest Monitoring Programs

The Forest Health Section of SRD participated in the annual gypsy moth monitoring program carried out by the Canadian Food Inspection Agency (CFIA). The CFIA protocol was followed in deploying pheromone-baited traps at strategically selected locations throughout the Green Area of the province. No gypsy moths were trapped at the 92 SRD sites.

Increased Awareness and Training

Increased Awareness

The 14th Annual Integrated Forest Pest Management Forum was held on November 4th at the Pine Room of the Northern Forestry Centre provided by the Canadian Forest Service in Edmonton. Nearly 100 persons representing forest industry, academic institutions, forest health research community and all three levels of government attended this Forum.

The proceedings included updates on the status of major forest health damaging agents on provincial land and National Parks. Current research on the mountain pine beetle, major defoliators, genomics, invasive and exotic forest pests and young stand pests were discussed at this forum. Dr. Jan Volney, a Senior Research Scientist affiliated with the Northern Forestry Centre, presented the keynote speech entitled "*Beyond the Pest Management Crisis: Lessons from Panarchy.*"

Training

Forest Health 100

The Forest Health Section, in collaboration with the Hinton Training Centre, offered Forest Health 100, a three-day course designed to educate the trainees in all aspects of the Forest Health Program in Alberta. A day and half long classroom session was followed by a day and half long field session. The classroom session covered SRD's business plan and administrative jurisdictions; the roles and responsibilities of the SRD and forest industry in various aspects of the Forest Health Program in Alberta; interpretation and application of SRD's forest health related legislation, policies and guides; categories of forest health damaging agents, their signs and symptoms and, biology and ecology of biotic agents in Alberta. The trainees were shown how to use Alberta's Forest Pest Damage Diagnostic System and management tactics, categories and timelines to manage the major forest health agents. The course culminated with training in integrating forest health knowledge into forest management planning and decision-making framework. During the field component of this course, the trainees were exposed to signs and symptoms of forest health damaging agents.

Young Stand Forest Pests

The Forest Health Section also offered a course on young stand forest pest management in collaboration with the Hinton Training Centre. A day-long classroom session on biology, ecology and management of young stand was supplemented by a day-long field session on young stand pests.

References

Alberta Sustainable Resource Development. 2007a. Mountain Pine Beetle Management Strategy, Publication No. T/154, Edmonton, Alberta. 14 pp.

Alberta Sustainable Resource Development. 2007b. Mountain Pine Beetle Heli-GPS Manual, unpublished document, Edmonton, Alberta.

Alberta Sustainable Resource Development. 2008a. Mountain Pine Beetle Detection and Management in Alberta: A revisable manual. Edmonton, Alberta. 105 pp.

Alberta Sustainable Resource Development. 2008b. Provincial Mountain Pine Beetle Decision Support System Interpretive Bulletin, Alberta Sustainable Resource Development, Edmonton, Alberta.

Carroll, A., Taylor, S.W., Régniére, J. and Safranyik, L. 2004. Effects of climate change on range expansion by the mountain pine beetle in British Columbia. Mountain Pine Beetle Symposium: Challenges and Solutions. October 30-31, 2004, Kelowna, British Columbia. In Shore, T.L. and Stone, J.E. (editors), Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Information report BC-X-399. Victoria, BC. 298 p.

Cooke, Janice, Assistant Professor, Department of Biological Sciences, University of Alberta, Edmonton, Alberta.

Ranasinghe, S.K. and Kominek, C. 1998. Spruce Budworm Management Guide, A revisable manual. Alberta Environmental Protection, Forest Health Branch, Edmonton, Alberta.

Ranasinghe, S.K. and Kominek, C. 1998. Forest Health Aerial Survey Manual. A revisable manual. Alberta Environment, Forest Health Branch, Edmonton, Alberta.

Appendix 1

Land-use Framework Regions and Corporate Areas in Alberta, 2010.